# NOTES ON SOME PROBLEMS OF ADAPTATION: 8. CONCERNING "MEMORY" IN ACTINIANS.[1]

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By a number of writers (cf. Parker, '17) it has been believed that certain animals of intertidal habitat may continue for a time to exhibit rhythmic movements, either of locomotion or of opening and closing, when they have been removed to aquaria and maintained under more or less constant conditions, and. further, that such periodic movements may be synchronous with the rise and fall of the tide. Unfortunately, many of the instances brought forward, *e.g.*, among the actinians, have been found upon closer scrutiny to yield no real evidence of a persisting "memory" of tidal events.

One of the commoner Bermudian sea-anemones, the red *Actinia bermudensis* Verr., occurs abundantly in caves along the shore and in other mud-free situations open at times to a moderate surf, but almost always between the tide lines. When the tide falls, the actinians retract the tentacles and constrict the column-sphincter. Commonly these sea-anemones hang upside down from the under faces of stones, but they are also abundant upon tiny ledges in the walls of small caves—in any event, occurring in situations such that they are rarely left in a tide pool, but are, on the contrary, freely exposed to the atmosphere by the retreating tide.

The much larger actinian *Condylactis passiflora* usually lives beneath low tide, with the column imbedded among stones; at extremely low tides, however, some individuals may be left a little distance out of water, and it is noteworthy that these do not retract the tentacles and contract the column, but instead hang down limply with the tentacles extended and the column passively stretched by the weight of the fluid in the interior cavity.

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The correlation, therefore, between a normal intertidal habitat and the practice of so contracting the body as to conceal the tentacles, decrease the surface for evaporation, and present a smoothly rounded exterior surface, is decidedly worthy of study. A variety (*prunicolor* Verr.) of *A. bermudensis* was found in bays on the south shore of Bermuda not under stones, but in small tide pools open to the sun, and also within the tidal zone. This variety is of a brownish hue, whereas the ordinary *A. bermudensis* is deep red. The color difference, apparently the only feature separating the two forms, was constant, and was even seen in young taken from the gastrovascular cavities of adults; the young of the red forms were always pink or scarlet, those of the brownish forms a light prune-color. The occurrence of such color differences has also been noted in related forms. Elmhirst and Sharpe ('20) state that the deep red *Actinia equina* becomes brown in the laboratory, and that the change "breeds true"—a remarkable observation, if correct, and one which should be followed up; it corresponds well with the conditions known in *A. bermudensis*. The red pigment of the latter species, readily extracted by acetone, is changed to a brownish hue by sunlight. The brownish anemones close up in the usual manner when the tide falls.

*A. bermudensis* reproduces "viviparously" throughout the year. Experiments could therefore be made with young actinians—"born" in the laboratory or taken from the cœlenteron of adults—which had never themselves been directly exposed as free individuals to the action of the tidal rhythm.

When the adults were removed from the natural location at low water and placed in an aquarium, they immediately relaxed and the tentacles were extended. After variable periods, of several hours, in non-circulating water, they closed again, although still completely covered by water. In a group of twenty individuals which were on one occasion (in January, 1917) placed in an aquarium, the period elapsing before closure was about three hours. These particular actinians all came from very nearly the same level above low water, and since most of them after a time opened again, I was led to look for a tidal rhythm. In point of fact, however, it is more than doubtful that any

such rhythm exists. The behavior of different specimens is anything but synchronous in the subsequent periods of opening and closing, and there is no tidal periodicity evident,—except perhaps in the matter of remaining expanded for about three hours after being immersed in water. But this interval is much the same regardless of the period of antecedent exposure; for specimens taken from the rock just after being left bare by the receding water are in this respect indistinguishable from those removed at the natural termination of the interval of exposure. After a sea-anemone has contracted, in still water, it may remain so for days, or it may after a time open "spontaneously." At any time it may be caused to expand by a faint local agitation of the water in its vicinity. In this behavior *A. bermudensis* was very similar to *Metridium* as described by Parker ('17). Sea-anemones attached to the rocks could always be caused to open by splashing over them a small amount of water; in this kind of response is to be seen the explanation of a sort of "anticipatory" expansion sometimes seen on the shore, wave-dashed droplets of spray being sufficient to induce some relaxation of the column-sphincter before the animals are actually covered by the sea.

Young *A. bermudensis* "born" in the laboratory aquaria exhibit precisely the same phenomena. In a group of six, one or two individuals may be found at any time tightly contracted, the others being in various degrees of expansion. But this behavior is not synchronous. One such group was rather carefully watched at intervals during 3 weeks. No rhythm of contraction was detectable in the individual behavior of these animals. Nevertheless, if they be taken from the water for a short time and then replaced, such young individuals promptly open and remain extended for about as long as do the adults under similar treatment, but after this they contract for variable periods.

Hence the rather fixed interval of expansion consequent upon immersion in sea water, although it agrees fairly well with the period of natural submergence, can hardly be ascribed to the establishment of a tidal habit; for the young actinians inexperienced in the matter of tides go through the same performance

as the adults. Of course, it might be supposed that during the period of low water changes in oxidation or the accumulation of metabolites within the cœlenteron might rhythmically influence the behavior of the embryos and juveniles. But the important point is the significance of purely mechanical stimuli, derived from motion of the water, for the relaxation of the column-sphincter. In a contracted sea-anemone, small or adult, expansion could always be secured by gentle movements of a glass rod in the nearby water. The necessary conclusion is that in the absence of such mechanical stimulation the actinian contracts; the latent period for this response is rather long. There is no evidence of tidal "memory."

*Summary.*—The behavior of *Actinia bermudensis* is considered with reference to its intertidal habitat. It is likely that the habit of contracting when uncovered by the sea is important for the maintenance of the species between tidal limits, but there is no evidence for persistence of the rhythm of contraction and expansion in the absence of the tidal rise and fall. After a period of about three hours in still water, the actinians close; they can at any time be caused to expand by agitating this water. Young individuals, never directly exposed to the tidal cycle, behave in the same manner.

CITATIONS.

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**Parker, G. H.**

'17 Actinian Behavior. Jour. Exp. Zoöl., Vol. 22, pp. 193–229.